

# **Surveillance Tools for Distributed Air/Ground Traffic Management**

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# Outline

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- **DAG-TM concept for information exchange**
- **Current cooperative surveillance functions in the NAS**
- **New surveillance capabilities under development**
- **Examples of application to DAG-TM elements**
- **Summary**

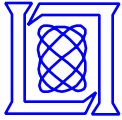


# Information Exchange in DAG-TM

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- **Core technology requirement: information exchange**
  - “...enabling of universal access / exchange of information among all NAS stakeholders.” \*
- **Core technology constraint: interoperability**
  - “...the minimum equipage required to operate in a DAG-TM system will be the same as that required to operate in the current ATC system” \*
- **Cooperative surveillance as a core technology provides**
  - **Aircraft (or Flight Object) information**  
Position, altitude, identification, velocity, intent, etc.
  - **Aircraft-derived atmospheric state information**  
Temperature, relative humidity, wind, etc.

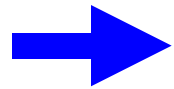
\* Concept Definition for DAG-TM v1.0



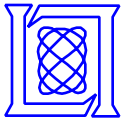
# Topics

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- DAG-TM concept for information exchange



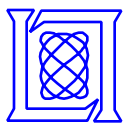
- Current cooperative surveillance functions in the NAS
  - Mode A/C/S operation
  - Air to air surveillance (TCAS)
- Capabilities under development
- Examples of application to DAG-TM elements
- Summary



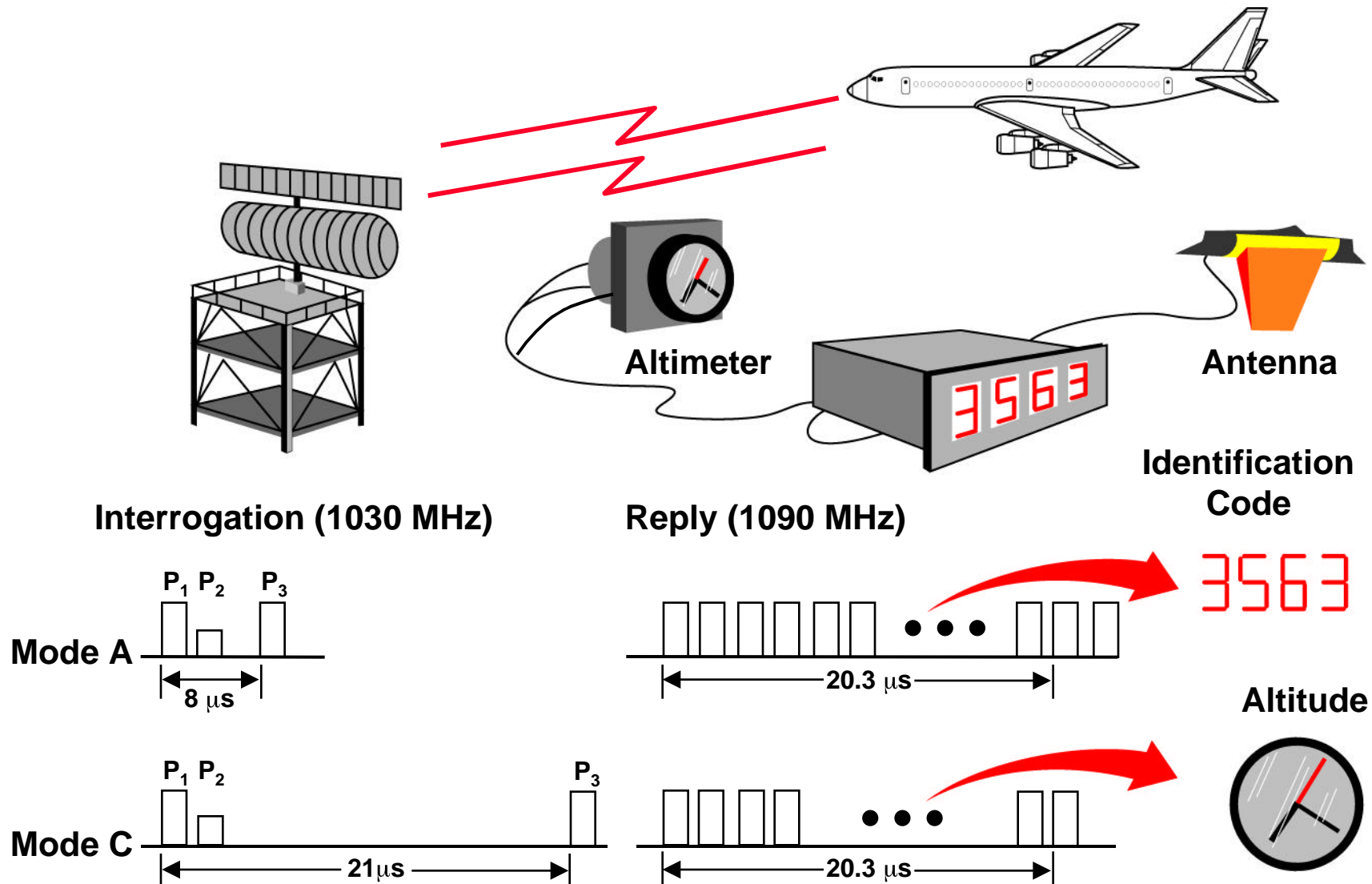
# Airport Surveillance Radar (ASR-9)

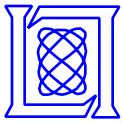
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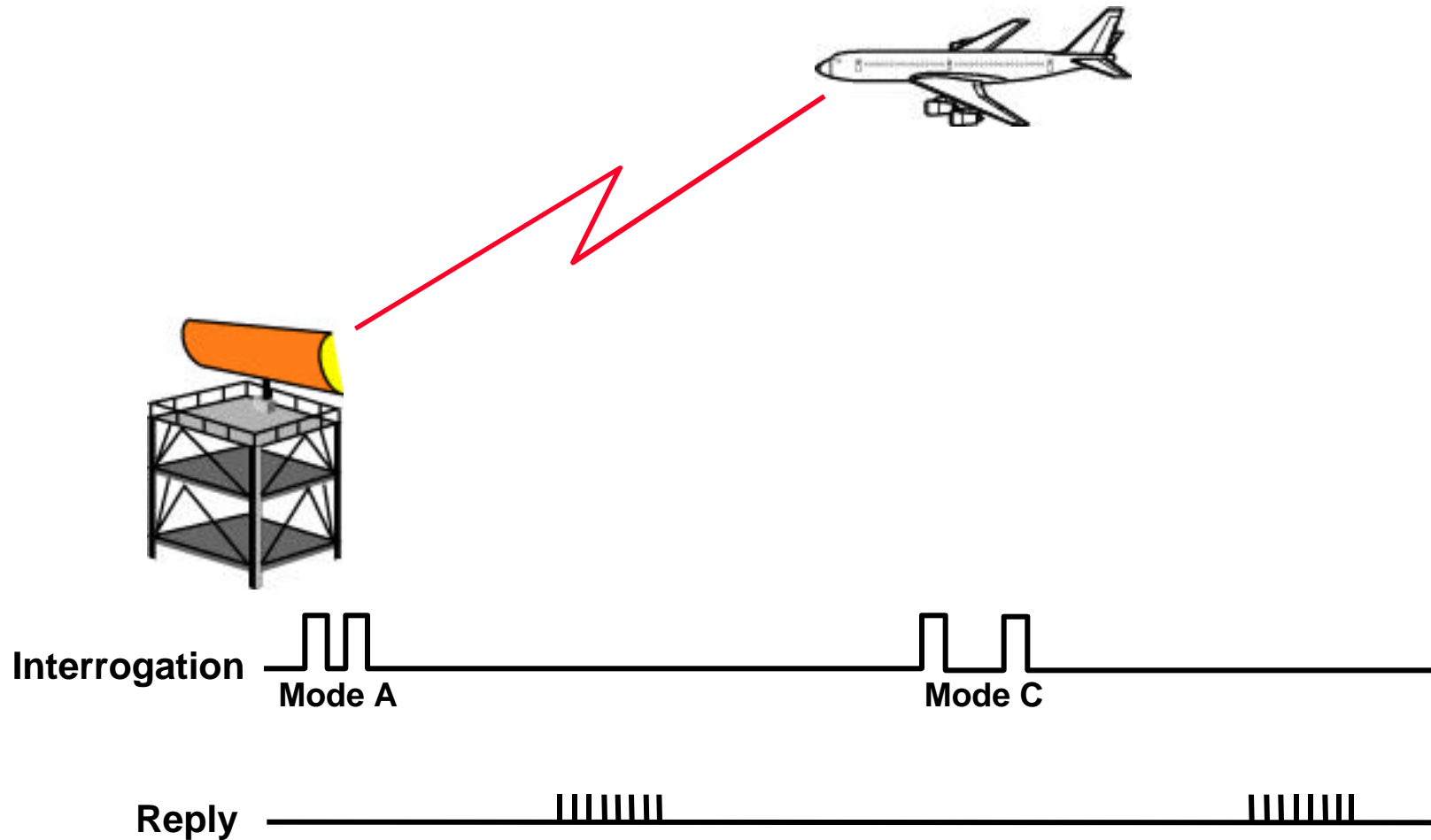


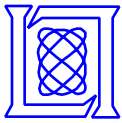
# Air Traffic Control Radar Beacon System (ATCRBS)



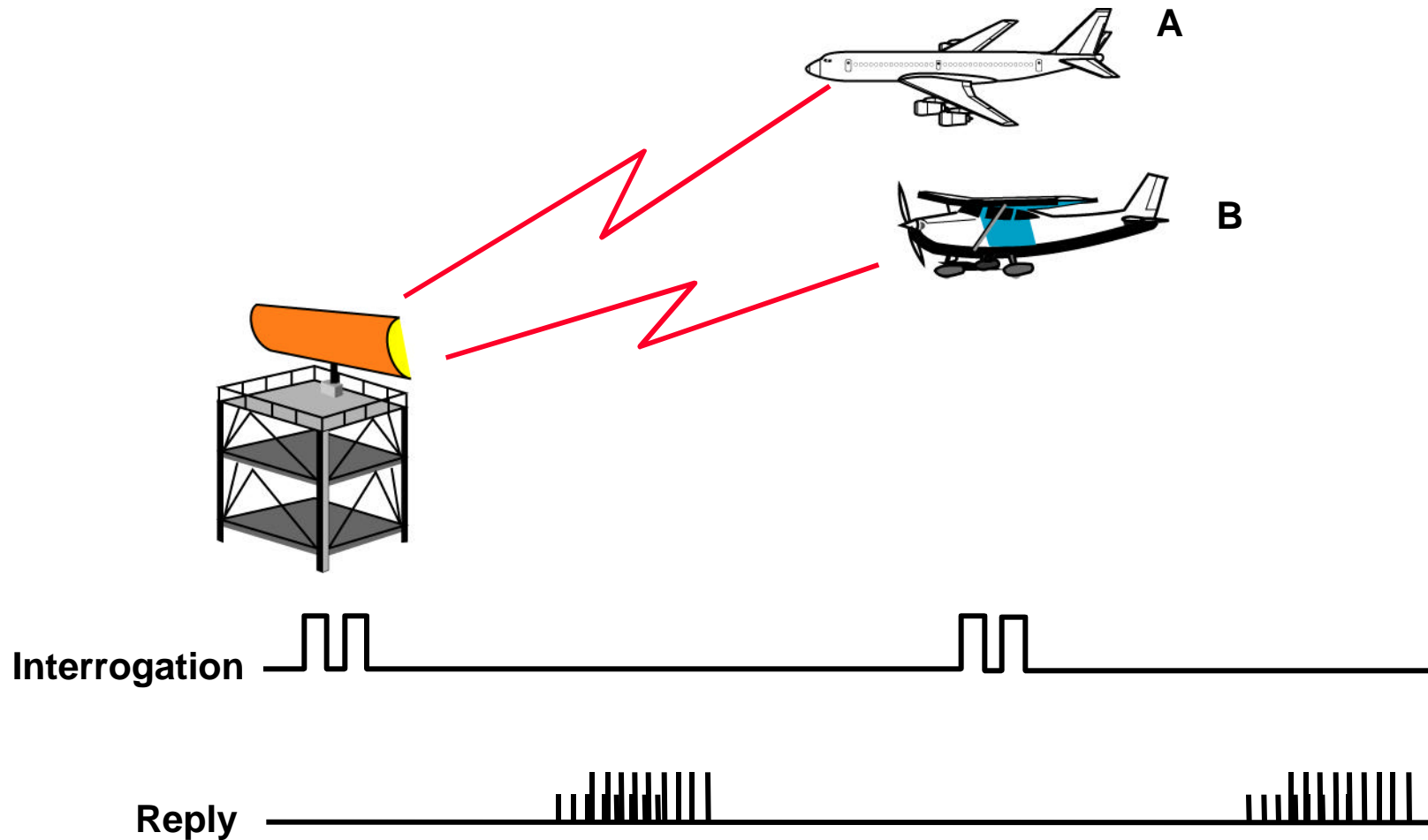


# ATCRBS Operation

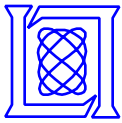




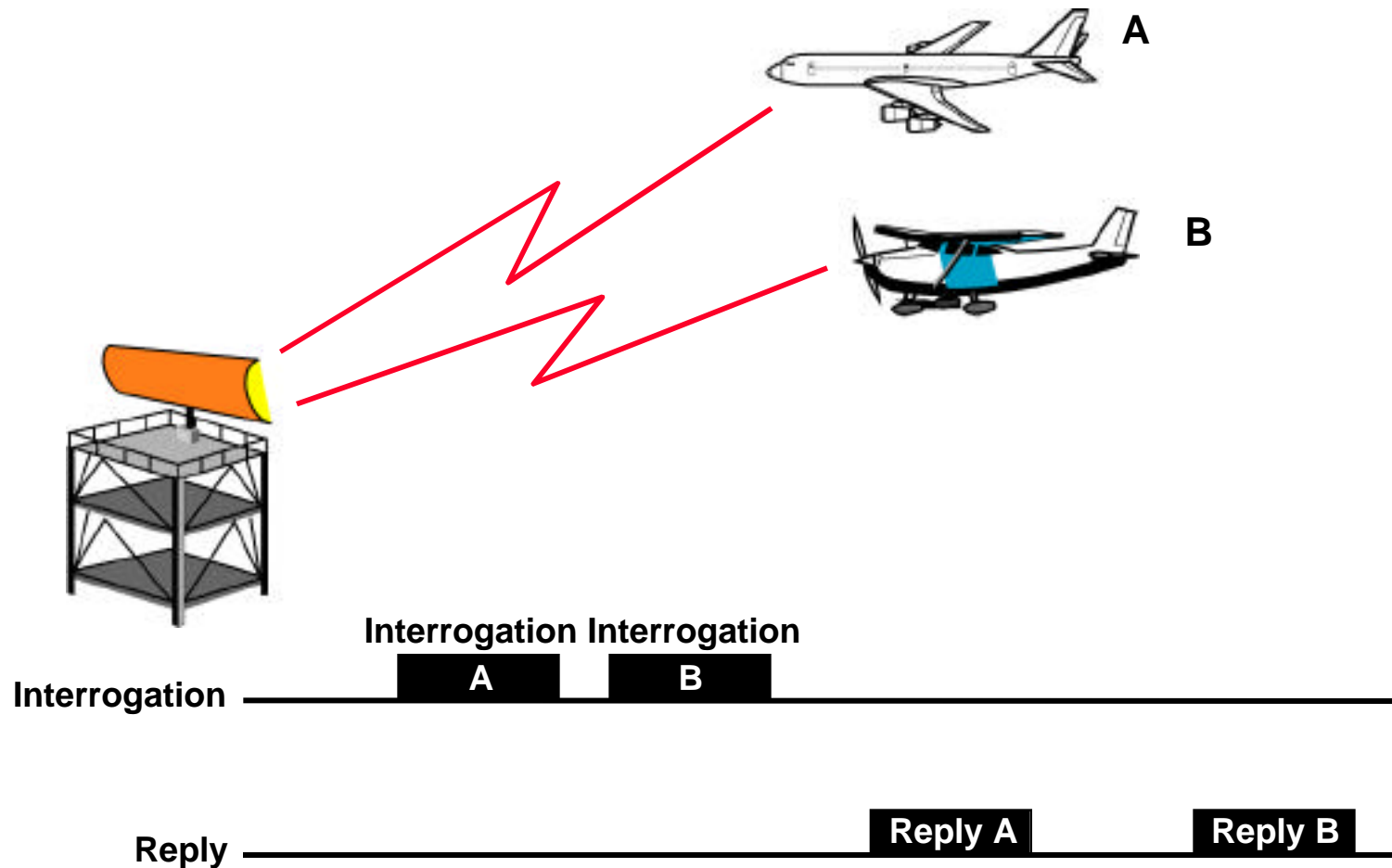
# Synchronous Garbling of ATCRBS Replies





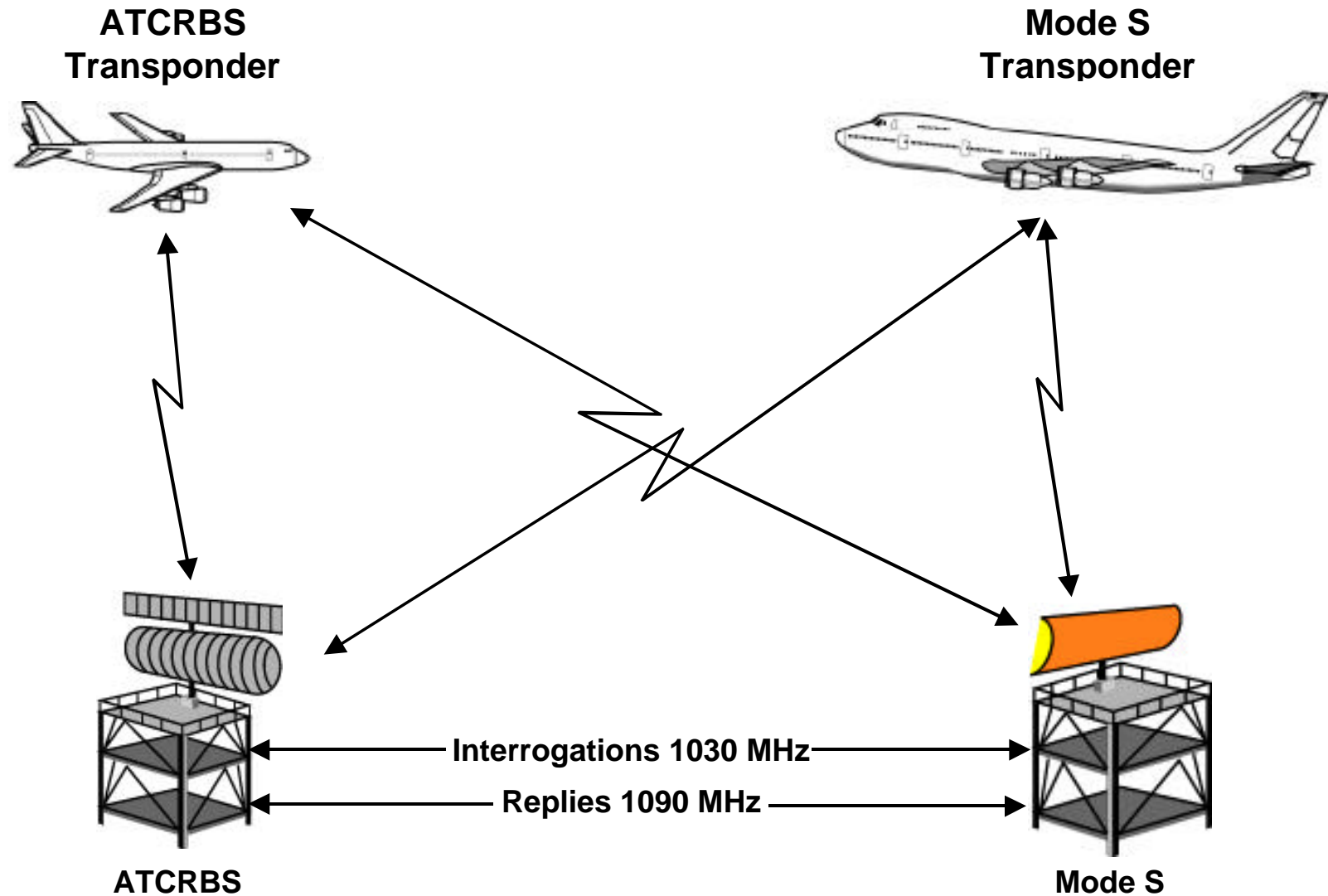


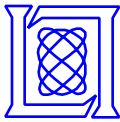
# Mode S Operation



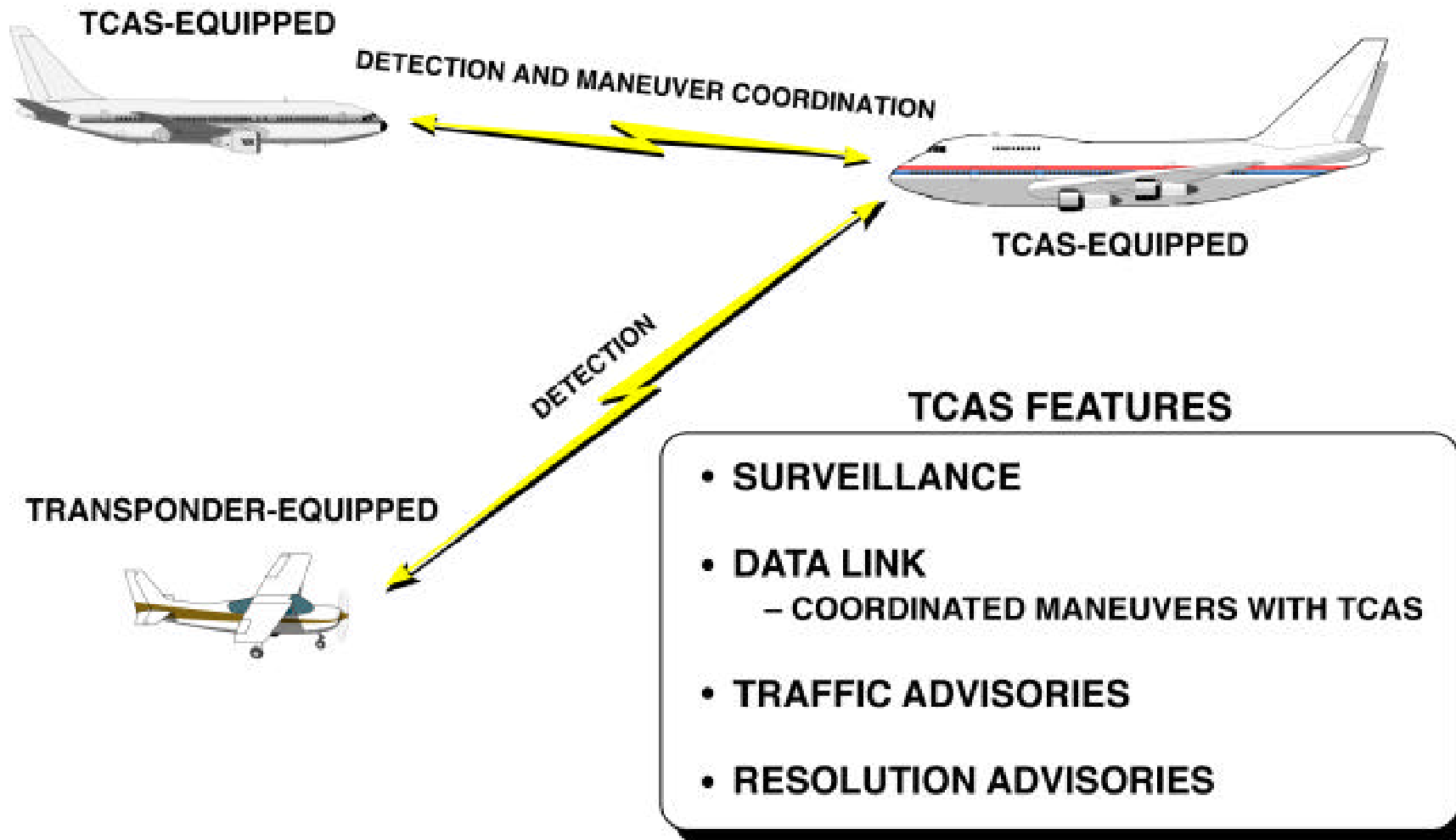


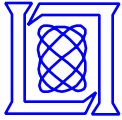
# Compatibility Between ATCRBS and Mode S





# TCAS – System Description

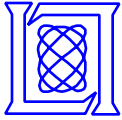




# Mode S “Enhanced Surveillance”

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- **Transponder contains 250, 56-bit data registers**
- **Forty registers currently defined by ICAO to contain**
  - **Aircraft-derived position reports (position, velocity, altitude, identification)**
  - **Aircraft state**
  - **Aircraft intent**
  - **Meteorological data**
- **Register data available for readout:**
  - **Air-to-ground by current Mode S ground stations**
  - **Air-to-air via TCAS cross link**



# Topics

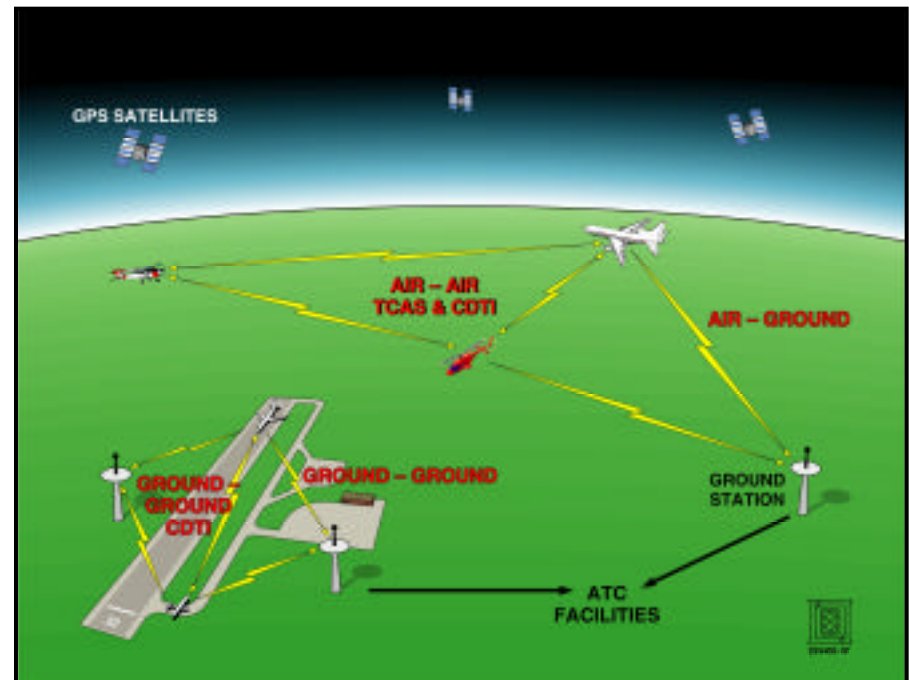
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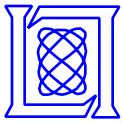
- DAG-TM concept for information exchange
- Current cooperative surveillance functions in the NAS
- ➔ • Capabilities under development
  - Automatic Dependent Surveillance Broadcast (ADS-B)
  - Time difference multilateration
- Examples of application to DAG-TM elements
- Summary



# Automatic Dependent Surveillance (ADS-B)

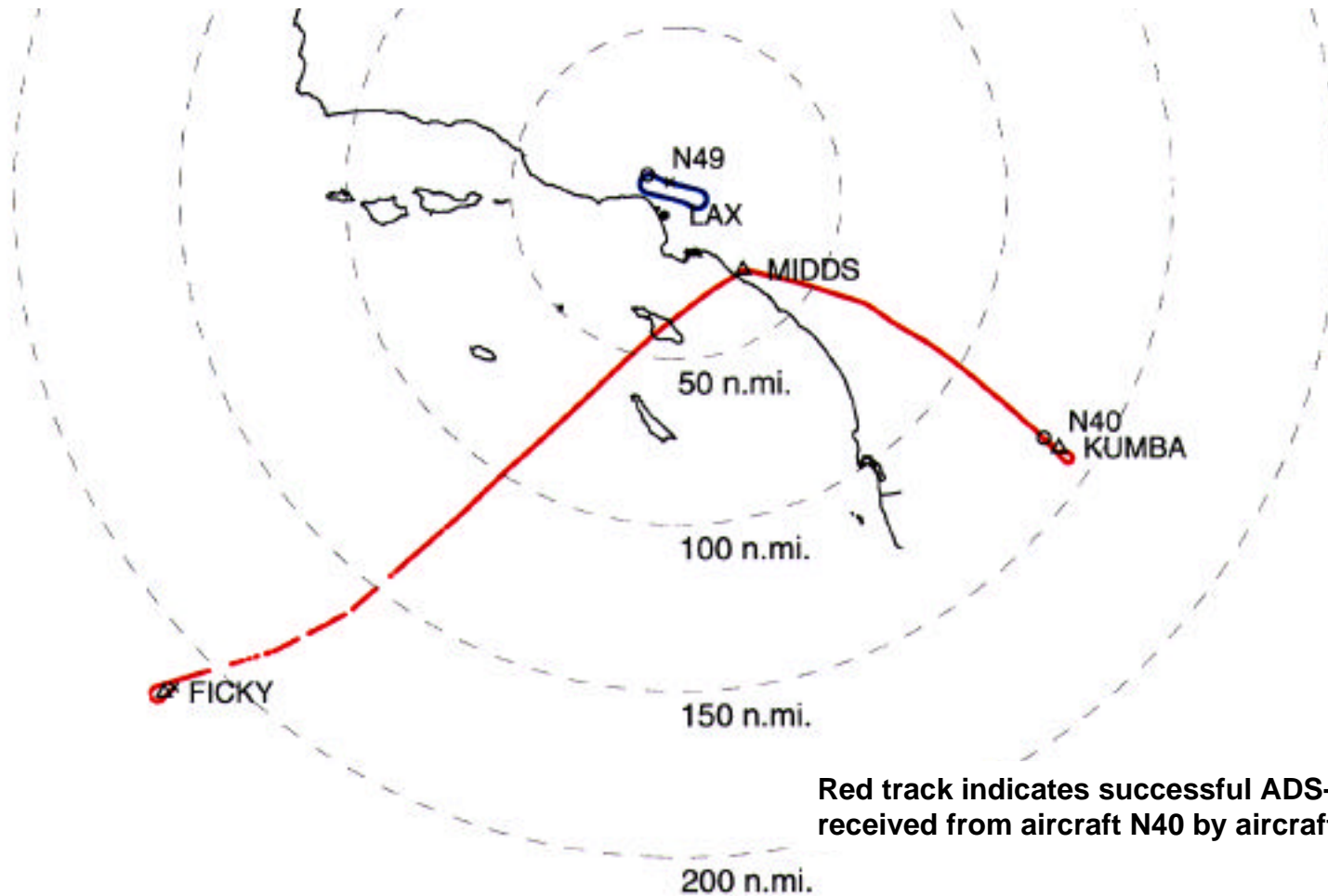
- **Concept:** Aircraft-derived position broadcast over common data link
- **Implementation:** Mode S transponders spontaneously broadcast (squitter) ADS-B data
- **Most stringent technical requirement:** 90 nmi air-to-air reception range in high interference environment (e.g., LA Basin)



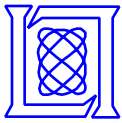


# LA Basin Flight Test Results

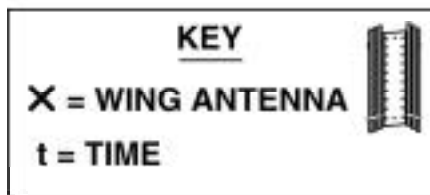
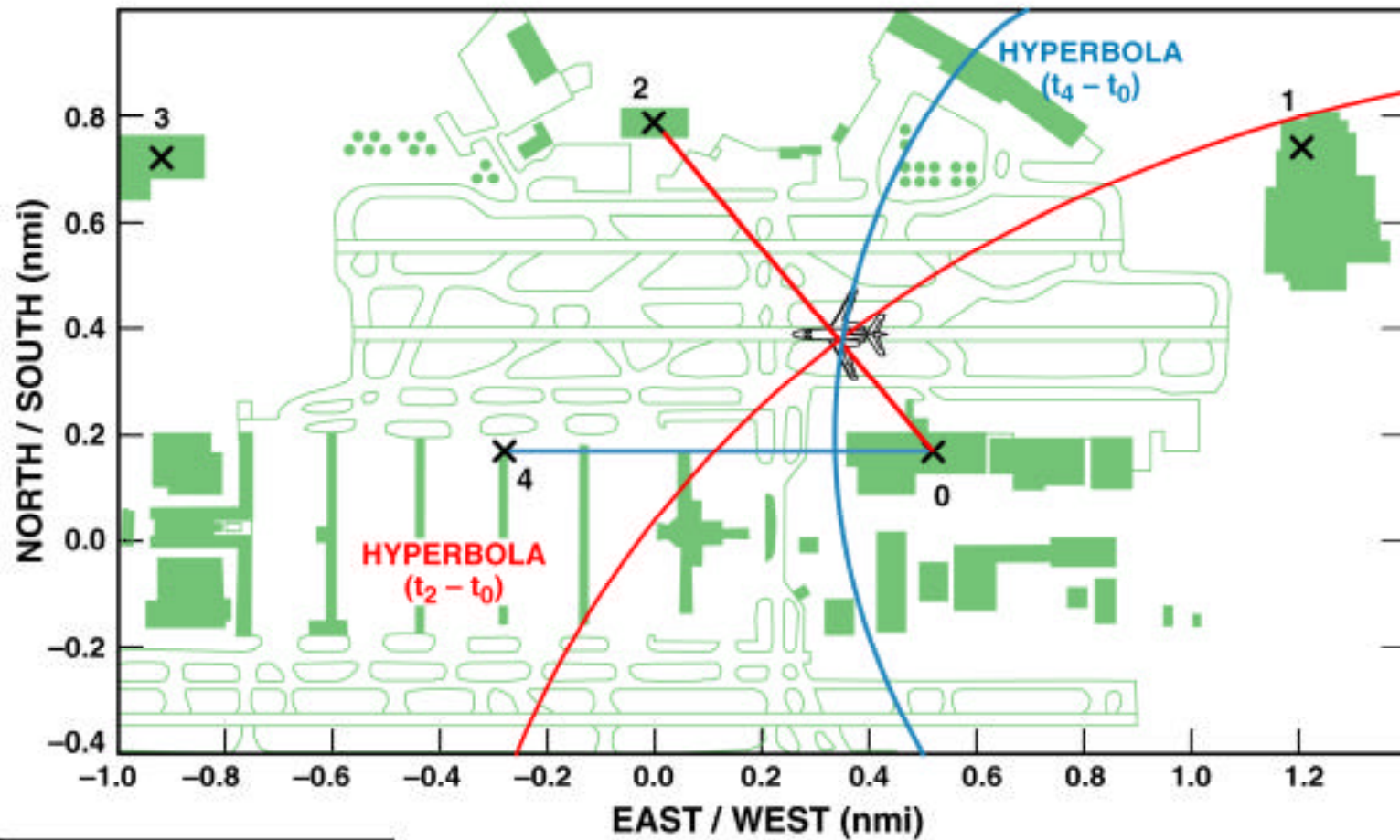
## Air-to-Air Surveillance Performance



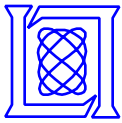
Red track indicates successful ADS-B position received from aircraft N40 by aircraft N49



# Time Difference Multilateration







# Multilateration Operation at DFW



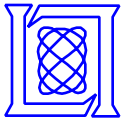
*Playback courtesy of Sensis Corporation*



# Topics

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- DAG-TM concept for information exchange
- Current cooperative surveillance functions in the NAS
- Capabilities under development
- ➔ • Examples of application to DAG-TM elements
  - Collaboration for user-preferred arrival metering
  - Self spacing for merging and in-trail separation
  - Intelligent routing for efficient active runway crossings and taxi
- Summary



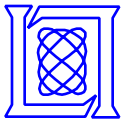
# Application of Surveillance DAG-TM

## Collaboration for User-Preferred Arrival Metering

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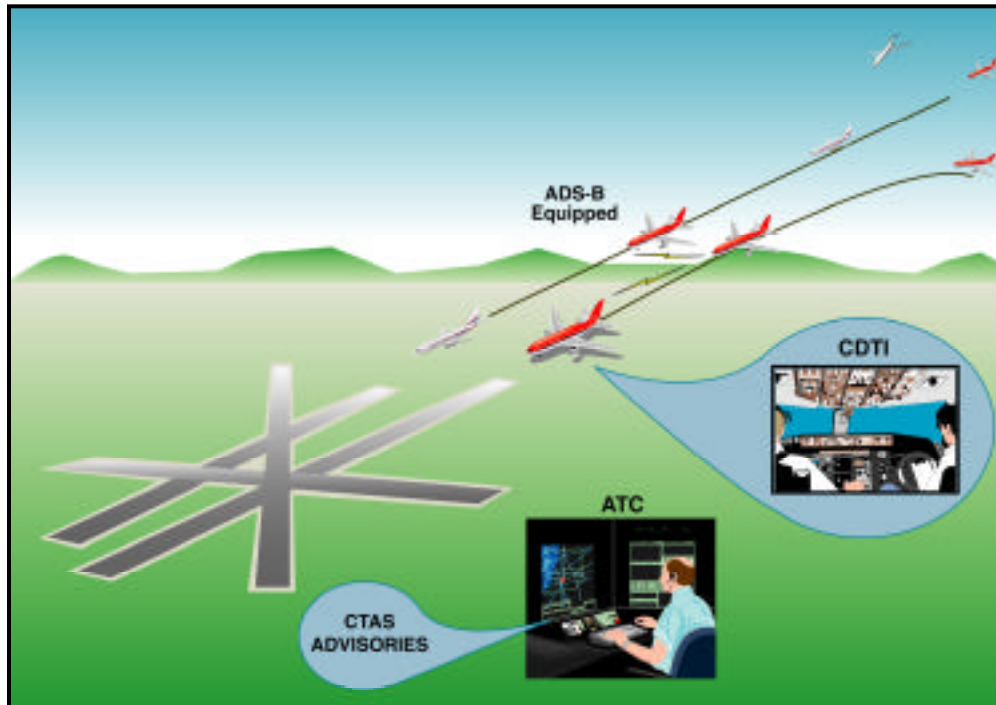


- Accurate measurements of aircraft and atmosphere state yield improvements in
  - Trajectory prediction
  - Conformance monitoring
- Research questions
  - What data is required?
  - What is the quantitative relationship between data quality and achievable benefits?

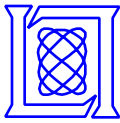


# Application of Surveillance to DAG-TM

## Self-Spacing for Merging and In-Trail Separation

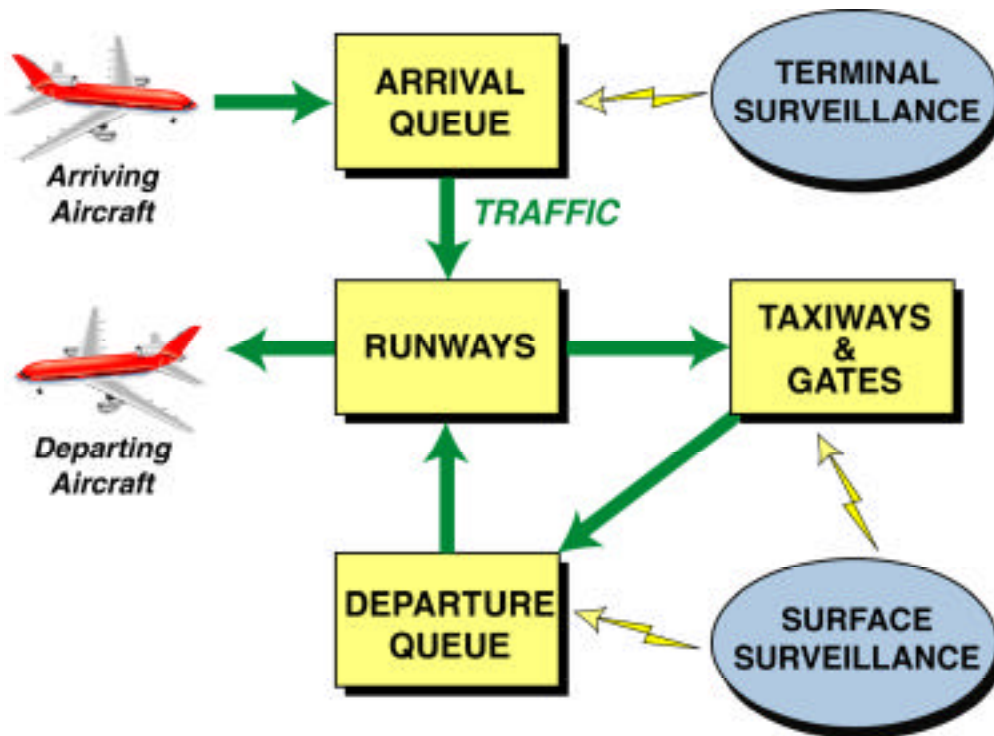


- CDTI enabled by air-to-air surveillance enables
  - Improved approach and departure spacing
- Research questions
  - What is the operational concept for the interaction of airborne and ground tools?
  - What data must be exchanged?
  - What is the relationship between technical system performance and achievable benefits?

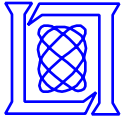


# Application of Surveillance to ATM

## Intelligent Routing for Efficient Active-Runway Crossings and Taxi



- **Direct measurement of surface traffic state yields**
  - More efficient surface movement
  - Reduced potential for surface accidents
- **Research questions**
  - What are current airport surface delay mechanisms?
  - What are appropriate delay countermeasures?
  - What are appropriate safety measures?



# Summary

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- **Cooperative surveillance forms the principal basis for determining the “state” of air traffic in the NAS**
- **Mode S and TCAS are mature surveillance systems that have been well validated by operational experience and include substantial unexploited capabilities**
- **Transponder multilateration and ADS-B enable new airport surface and air-to-air surveillance capabilities**
- **DAG-TM research must quantify the surveillance performance required to achieve operational benefits**